Directorate of Intelligence

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Possible Airborne Laser Research, Development, and Testing at the Kazan Missile Propulsion Test Facility

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An Imagery Analysis Report

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Possible Airborne Laser Research, Development, and Testing at the Kazan Missile Propulsion Test Facility [redacted] 25X1 25X1

Summary

The Soviet Union appears to have conducted a laser research, development, and test program at the Kazan Missile Propulsion Test Facility from mid-1978 through early 1980. [redacted] 25X1 25X1

The laser that was under development at Kazan may have been designed to draw both its gas supply and electric power from an RD-3M-500 jet aircraft engine. [redacted] 25X1 [redacted] The RD-3M-500 engine was designed [redacted] in the 1950s and may have been the jet engine used to drive the turbogenerator. 25X1 25X1

Modifications to the existing test facilities and new construction for the laser program at Kazan began in 1975. The new construction included a new exhaust system for the test cell, a new diagnostics building, and a [redacted] laser test range with a target building. Based on completion of construction and the subsequent dismantlement of portions of the facility, testing of a laser could have taken place from mid-1978 through early 1980. We do not have any information to indicate the success of the laser research, development, and test program at Kazan. [redacted] 25X1 25X1

Information available as of 26 June 1983 has been used in this report. [redacted] 25X1

The author of this paper is [redacted] formerly with the Office of Imagery Analysis. Comments and queries are welcome and may be directed to the Chief, Technical Systems Division, OIA, on [redacted] 25X1

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[redacted] it may have been part of the R&D effort for the probable high-energy laser system that the Soviets have installed and tested on an IL-76 (Candid) transport aircraft since the early 1980s. 25X1

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Introduction

The Kazan Missile Propulsion Test Facilty (MPTF) is located in an isolated area 15 kilometers west of the city of Kazan (figure 1). The MPTF has been involved in the development and static testing of both liquid- and solid-fuel propulsion systems, including surface-to-air missiles and antiballistic missiles. [redacted] some of the propulsion systems tested at the MPTF were developed by a Motor Design Bureau (MPB) located near Aircraft Engine Plant 16 in Kazan. [redacted] Laser testing at the Kazan facility could have occurred from mid-1978 to early 1980. When dismantlement of the laser R&D facility began in early 1980, an RD-3M-500 jet aircraft engine was observed, indicating that it had been used in the test program. [redacted] 25X1 25X1 25X1

The Kazan Missile Propulsion Test Facility

The Kazan MPTF covers approximately 70 acres and consists of two main areas, a western support area and an eastern test area, which are separated from each other by a security fence with a single gate [redacted] The western support area is involved in the assembly and checkout of propulsion systems. The eastern test area is involved in propulsion-system testing and contains a high-energy laser research, development, and testing facility. The HEL R&D facility consists of the horizontal test cell building (HTCB), a diagnostics building, a control building, a laser range with safety panels, and a target building [redacted] 25X1 25X1 25X1

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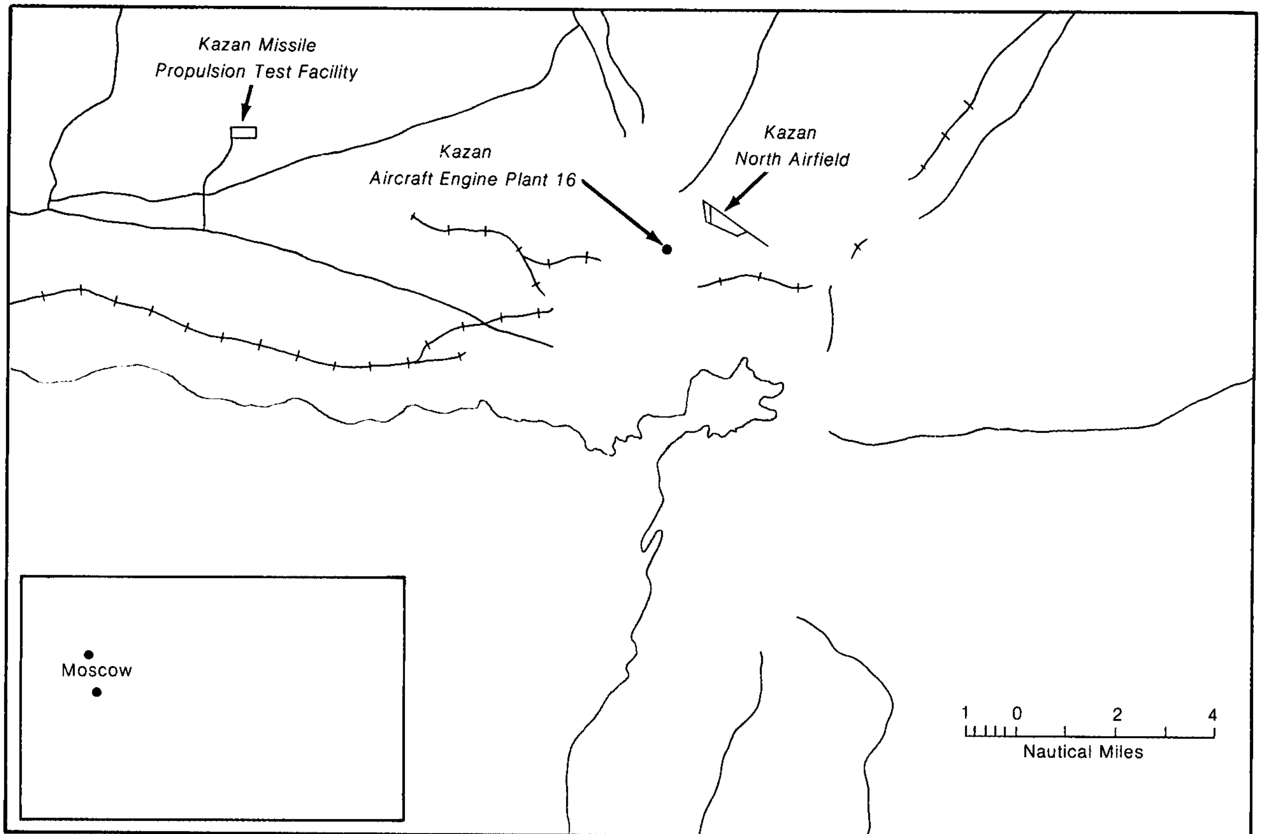
Figure 1

Location of Kazan Missile Propulsion Test Facility



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The HTCB

The HTCB is similar to a horizontal test cell called the aerodynamic and propulsion test unit (APTU) at the Arnold Engineering Development Center, Arnold Air Force Station, Tullahoma, Tennessee (figure 4). Like the APTU, the HTCB is probably a true temperature test facility used for testing air-breathing propulsion systems and rockets while simulating actual flight conditions at supersonic velocities. Also like the APTU, it has a high-pressure air storage reservoir and regenerative storage heaters. [10] Items observed to be associated with the HTCB include collapsible conduits, an RD-3M-500 jet engine, jet engine housings, aircraft fuel tanks, and special air conduits. [redacted]

The HTCB [redacted] high. A diffuser/exhaust duct and craneway are located at the east end, and a one-story wing is located on both the north and south sides. The main part of the building is a rectangular high bay [redacted] and houses a test cell [redacted] The main part of the HTCB probably also houses offices, an instrumentation room containing monitoring equipment, a computer area, an electrical equipment room, a mechanical equipment room, and a shop room with a tool crib area. [redacted]

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Figure 4 25X1

Aerodynamic and Propulsion Test Unit (APTU), Arnold Air Force Station, Tennessee 25X1

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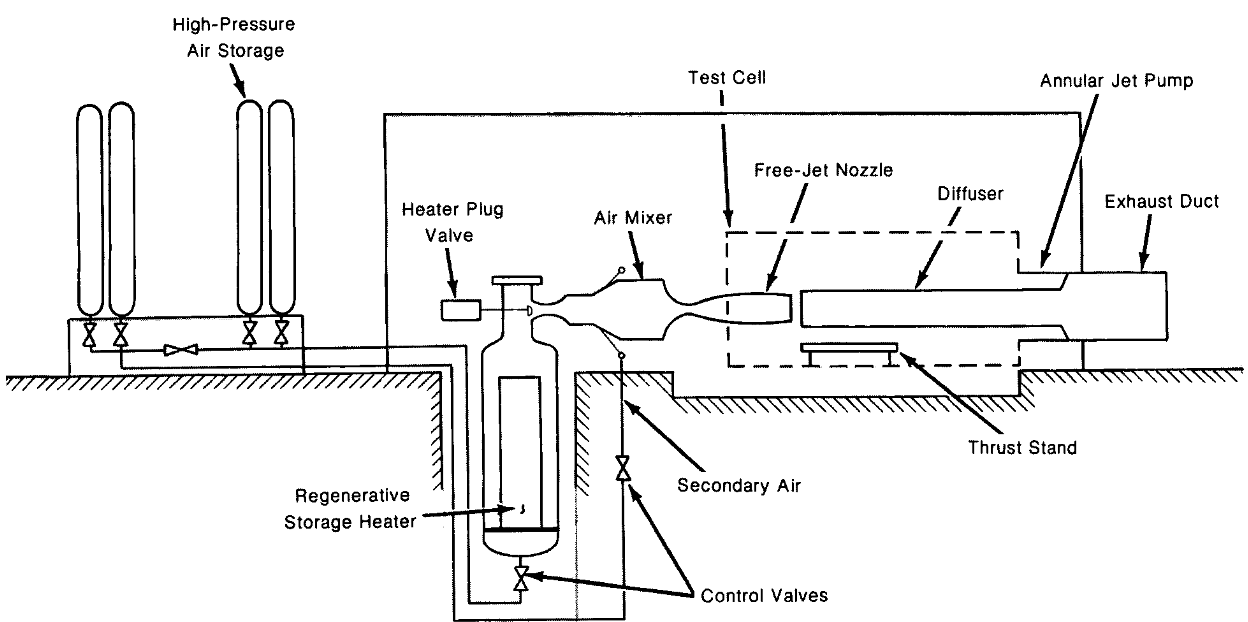

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The exhaust duct extends [redacted] from the high-bay area of the HTCB, widening from a [redacted] square opening that is directed upward. A curved upward exhaust duct is suitable for use with a jet aircraft engine which produces gases that need to be accelerated and directed upward into the atmosphere. [10] The exhaust duct at the HTCB prior to 1975 was horizontal and completely linear, making it suitable for use with rocket engines with high-pressure gases that move at a rapid velocity [redacted] A pipeline extends across the HTCB roof from a bank of gas bottles to the northeast corner where the diffuser/exhaust duct exits the building. The pipeline may supply pressurized gas for an ejector system that would speed the flow of gases through the exhaust duct. The pressurized gas could be either compressed air or nitrogen that is mixed with air. [redacted] 25X1

Two banks of vertical pressure bottles probably containing compressed air are located along the south wing of the HTCB. An additional bank of pressure bottles is at the southwest end of the building. The bottles are [redacted] Pipelines extend from the gas bottles to an air compressor building and also across the HTCB roof to the northwest corner where regenerative storage heaters are probably located. [redacted] 25X1

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[redacted]

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<u>Collapsible Conduit Associated with the HTCB.</u> Sections of a collapsible conduit [redacted] 25X1 This was the first time that this type of conduit had been noted at a Soviet laser range. The sections, which have bellows-like folds, could have been expanded to connect the HTCB to the diagnostics building [redacted] 25X1 We believe that the conduit is used to enclose the laser beam path from the HTCB to the diagnostics building during beam propagation. The use of a conduit for beam propagation would serve as both a safety measure and a 25X1 means of eliminating any atmospheric interference to the laser beam before it reaches diagnostic equipment. [redacted] 25X1 [redacted] the collapsible conduit was removed. [redacted] 25X1

[redacted] 25X1

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Aircraft Engine and Air Conduit Associated with the HTCB. On [redacted] two engine housings, used for mounting jet engines to an aircraft, were observed on the HTCB exhaust apron. The engine housings had the same overall dimensions as those used to hold the RD-3M-500 aircraft engine. In December 1980, after the HEL R&D program had ended, an RD-3M-500 aircraft engine and an air conduit with a mixing chamber that probably contained expansion nozzles were observed for the first time at the HTCB [redacted] Three charred air conduits of the same configuration, but with mixing chambers, were discarded in the boneyard, and aircraft engine fuel tanks were discarded at the end of the exhaust apron. [redacted]

These sightings of an aircraft engine and associated air conduits and fuel tanks at the HTCB indicate that an aircraft engine was being used in the HTCB while an HEL R&D program was under way. [redacted]

The Diagnostics Building
The diagnostics building is a small, rectangular, gable-roofed structure erected on the HTCB's exhaust apron, between the curved end of the diffuser/exhaust duct and a dirt backstop. The building has an annex on its east and west sides and has been canted at an angle to the HTCB. The angle places the front of the diagnostics building in alignment with the graded laser range,

[redacted]

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safety panels, and target building. The positioning of the diagnostics building also places an opening on its west wall in direct line-of-sight with an opening in the HTCB. [redacted] 25X1 25X1

At the time the diagnostics building was being fitted out, a number of diagnostic artifacts, probably optics/mirror mounts, were observed near the building. Elevated conduit sections, possibly beam ducts for use between diagnostic equipment, were also present [redacted] 25X1

An elevated pipeline/conduit connects the diagnostics building to the first two banks of gas bottles along the south side of the HTCB. The pipeline probably supplies compressed air to the diagnostics building for such purposes as purging equipment, floating an optical bench, and conditioning the beam path. Another pipeline/conduit that runs along the ground between the two buildings probably supplies electric power to equipment in the diagnostics building. A second elevated pipeline/conduit connects the diagnostics building to the target building. This pipeline/conduit may carry electric cables for supplying power to the target building and to provide a data link between the two buildings. [11] [redacted] 25X1

A portal on the side of the diagnostics building facing downrange has a louvered cover. The cover [redacted] and is 25X1 probably hinged so that it can swing open to the side. The louvers allow for openings [redacted] It is 25X1 possible that the louvers can be individually opened and may protect the diagnostics building from reflected radiation from the targets downrange during alignment procedures. [redacted] 25X1 25X1

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Laser Range

The laser range slopes upward from the diagnostics building to the target building on an incline of about 4 degrees (figure 11). The range [redacted] and has six safety panels positioned along it. Each safety panel [redacted] and contains a circular hole. The diameter of the holes decreases the farther the panels are from the diagnostics building. Except for the last panel, each panel is approximately twice as far from the diagnostics building as the preceding one. The close spacing of the panels near the source of the propagating laser beam suggests that they serve a safety role. Accidental direct illumination by the laser, caused by beam misalignment, can be prevented by the outer opaque portions of the panels. The closer the first few panels are to each other, the less misalignment that is permitted. The surrounding area would be shielded from direct radiation by the series of panels and the target building itself. The panels would also help to block a portion of radiation reflected or scattered by obstructions along the beam path to the target building. Decreasing hole size is what one would expect for a fixed beam. [12,13] The safety panels' measured distances from the diagnostics building and the progressive decrease in diameter of the holes in the panels agree favorably with the required calculated diameters, at equivalent distances, for a focused beam of [redacted] exiting the [redacted] portal of the diagnostics building [redacted]

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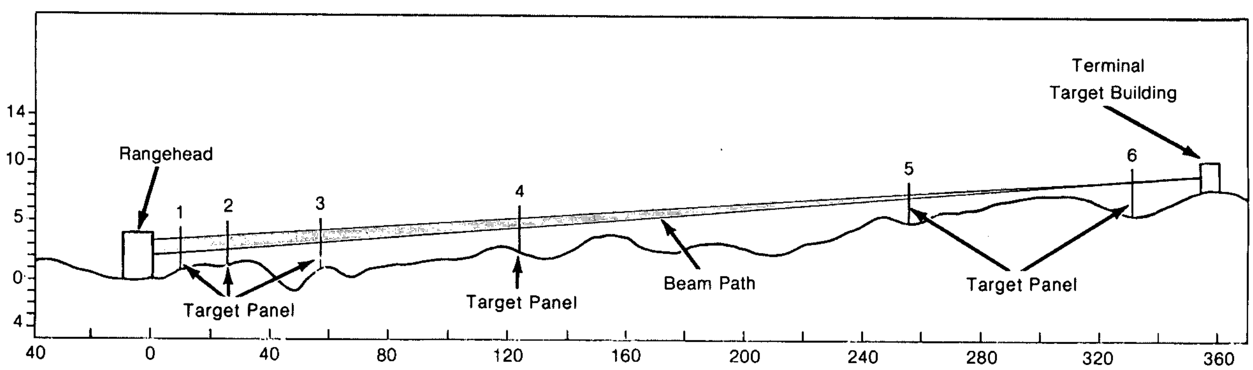
Figure 11

Graded Line-of-Sight Range, High-Energy Laser R&D Facility, Kazan MPTF 25X1



Scale in Meters

[redacted] 25X1

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The opening in several of the panels has occasionally been observed filled, suggesting that the panels hold removable instrumentation packages for laser beam diagnostics. Such packages have been used at US ranges for measuring intensity profiles of high-energy laser beams. One such US package, called a holey plate thermocouple array, consists of calorimeter disc thermocouples located behind a regular array of holes in a metal or graphite piece (figure 12). These packages can be moved from panel to panel to measure the beam profile at various distances. [11] 25X1

A pole with a short perpendicular arm was observed at the edge of the HTCB exhaust apron in front of the diagnostics building. The pole probably serves as a support for meteorological sensors. A solid fenceline on both sides of the range near the target building extends from the building to just past the fifth safety panel. This fence is probably intended to block any possible reflective scatter of the beam from the fifth and sixth safety panels or the target building.

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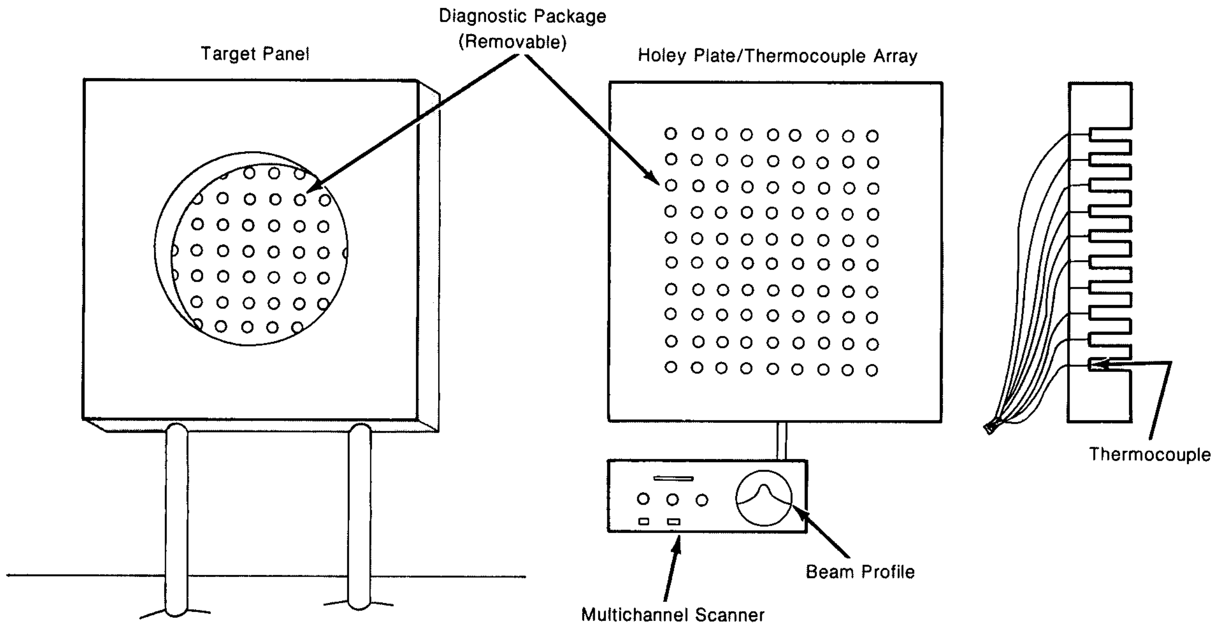
Figure 12

Holey Plate Thermocouple Array



[redacted] 25X1

What appears to be an observation stand is positioned to the east side of the range near one of the solid fences. The stand consists of two walls and flooring. The west wall facing the range is higher than the east wall and has large rectangular openings which may serve as windows. The north and south sides of the stand are open and the top is covered with canvas. [redacted] 25X1 25X1

__The Target Building__

The target building consists of two parts [redacted] 25X1 The first part to be constructed probably contains support equipment such as storage tanks for cooling water. 25X1 The part of the target building that is in direct alignment with the safety panels rests on a poured concrete base next to the support area and is connected by an elevated pipeline to the diagnostics building. The pipeline probably carries electric cables--providing power and a data link--to monitoring equipment and probably to a calorimeter positioned on the concrete base. [redacted] 25X1

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A water truck that was observed near the target building during the time the range was believed to be operational may have been used to fill the storage tanks in the target building. Water can be used as a heat reservoir in a calorimeter. If this is the water truck's function, its presence could indicate periods of active laser testing. 25X1

Construction Chronology

Construction of the laser facility began in May 1975 with modifications to the HTCB. Construction of the diagnostics building, range, and target building began in November 1975. 25X1

The HTCB. The HTCB was first observed externally complete in early 1968, and we estimate that it was operational by mid-1968. Engine testing of liquid-fuel systems probably began in mid-1968, when crates containing test articles were first observed at the HTCB. Testing of solid-fuel motor systems probably did not occur until early 1970, when spent solid-fuel rocket motors began appearing in a nearby boneyard. Also at this time, a solid-propellant-associated assembly and checkout building was completed in the western support area. 25X1

The first modification to the HTCB was observed in May 1975 when a bank of gas bottles was installed at the southwest end of the building. The bottles were connected by pipeline to two banks of gas bottles along the building's south wing. In November 1975, the recessed roof that covered half of the craneway was removed. 25X1

During April 1976, the linear exhaust duct was being dismantled and parts for a larger exhaust duct were observed nearby. Also at that time, a new pipeline was installed across the HTCB roof from gas bottles at the southwest corner to the diffuser at the northwest corner. Assembly of the new diffuser/exhaust duct was completed by September 1976. 25X1

By late September 1976, a new pipeline was installed from a new air compressor at an altitude simulation building in the eastern test area to the HTCB. The new pipeline joined the HTCB pipelines at the same point as the HTCB air compressor building's pipeline. A one-story addition to the HTCB had been constructed between the new bank of gas bottles and the south wing. By October 1976, the HTCB compressor building's pipeline had been removed, indicating that the compressor at the altitude simulation building was now supplying the HTCB with compressed air. 25X1

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The first indication of dismantlement was the removal of a portion of the southwest edge of the HTCB's exhaust apron on [redacted] Further dismantlement was noted on [redacted] when the diffuser/exhaust duct to the HTCB had been removed. [redacted] a section to a new linear exhaust duct suitable for rocket engine testing was observed near the HTCB. [redacted] the linear exhaust duct was assembled and in place. [redacted] 25X1 25X1 25X1 25X1 25X1

<u>The Diagnostics Building</u>. Preparations for constructing the foundation of the diagnostics building were observed under way in November 1975. By August 1976, the roof was in place and by late September 1976, the main part of the building was complete. [redacted] diagnostic artifacts were observed at the building. By April 1977, the diagnostics building was connected to the HTCB and the target building by elevated pipelines. By late December 1977, an annex was added to the west side of the diagnostics building. By late July 1978, another annex was added to the east side of the building. [redacted] 25X1 25X1

The first evidence of dismantlement occurred in late June 1980, when a portion of pipeline connecting the diagnostics building to the target building was removed. [redacted] equipment was observed being removed from the diagnostics building. By the following coverage [redacted] the diagnostics building had been separated into two parts. By [redacted] the diagnostics building had been moved and reassembled off to one side of the linear exhaust duct. [redacted] 25X1 25X1 25X1 25X1 25X1 25X1 25X1

<u>The Laser Range</u>. Grading of the laser range was first observed [redacted]. Grading was complete [redacted] fenceline was observed under construction on both sides of the range near the target building. [redacted] the fences were completed. [redacted] 25X1 25X1 25X1 25X1

[redacted] no safety panels were present at the range. [redacted], three safety panels were present, but they were not yet positioned along the range. [redacted] six safety panels were in place along the range. [redacted] 25X1 25X1 25X1 25X1 25X1

The first evidence of dismantlement occurred [redacted] when it was noted that the safety panel nearest the diagnostics building was torn. Removal of the first three panels was observed [redacted] The remaining three panels have stayed in place. [redacted] 25X1 25X1 25X1

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The Target Building. The poured concrete base for the target building was [redacted] the first part of the target building was erected alongside this concrete base. [redacted] the other part of the target building was erected on the concrete base and the pipeline connecting it to the diagnostics building was in place. [redacted] 25X1 [redacted] a water truck was first observed near the target building. The truck was observed in place as late [redacted] No dismantlement of the target building has occurred. [redacted] 25X1 [redacted]

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Laser R&D Program 25X1

The laser R&D program at the Kazan MPTF may have centered around the involvement of [redacted] in both laser R&D and the use of 25X1 his RD-3M-500 jet aircraft engine. It is not uncommon for the Soviets to use older aircraft engines in a research program, especially if using a proven technology will help in meeting stringent due dates. The use of the RD-3M-500 in an R&D program is further indicated by the positioning of the air cowling on the back of the engine rather than the front. This is a standard practice when a special air conduit is attached to perform exhaust studies or research. [redacted] 25X1

[redacted]

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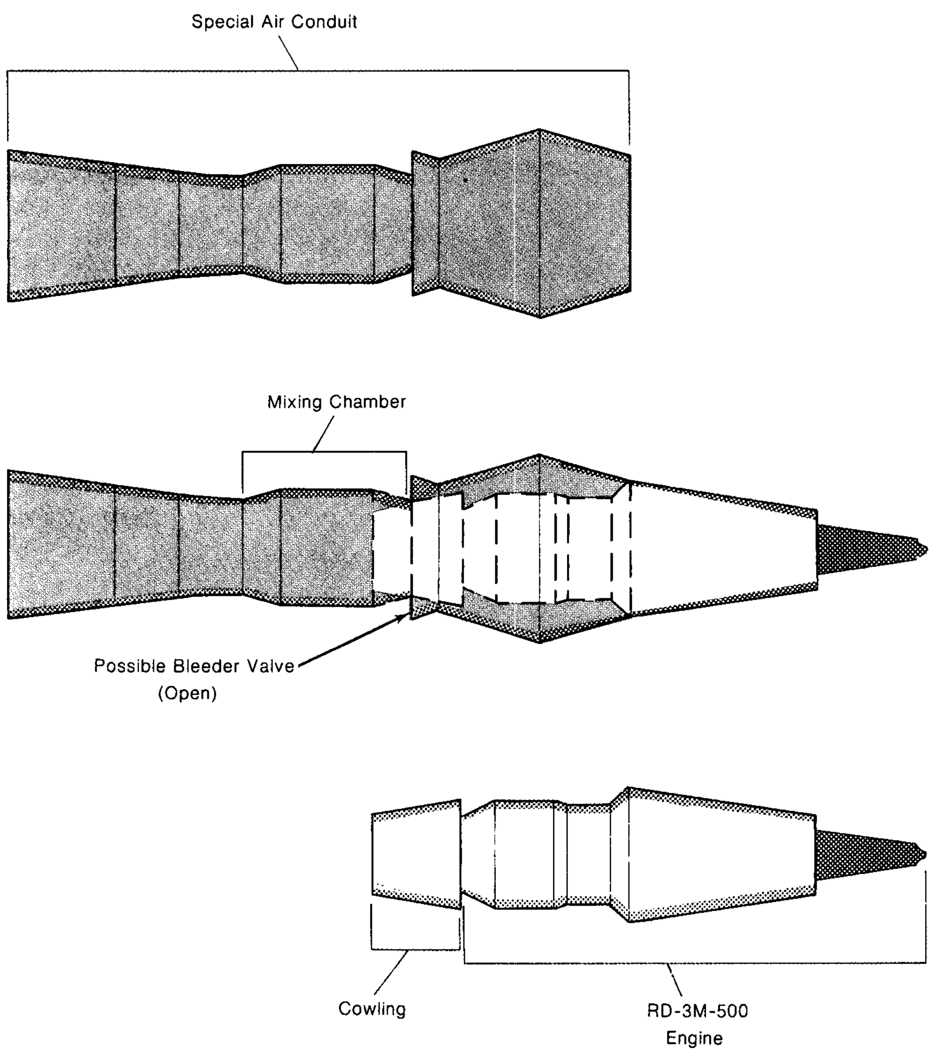
The modifications to the HTCB that began in 1975 were probably to accommodate an RD-3M-500 aircraft engine with a special air conduit in the test cell. The larger-than-usual diameter of the special air conduit indicates that it has a mixing chamber that probably contains expansion nozzles. Computer graphics, [redacted] illustrate how the two test components could fit together (figure 13). As shown, the engine is 25X1 25X1 25X1

Figure 13

RD-3M-500 Aircraft Engine and Special Air Conduit



[redacted] 25X1

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perfectly matched to the special air conduit. The computer graphics also show that the air conduit has what could be a bleeder valve, which controls the amount of engine exhaust entering the mixing chamber in the conduit. When the bleeder valve is completely closed, all engine exhaust flows through the mixing chamber. When the valve is open, some engine exhaust could bypass the mixing chamber and exit directly through the diffuser/exhaust duct. In the test cell, the open end of the special conduit extends into the diffuser/exhaust duct This could permit a laser, located in the mixing chamber, to be electrically powered by the jet engine and to use the jet engine exhaust gases as its gas supply. We believe that the RD-3M-500 installed in the HTCB performed both functions, because using a test-cell building to run a jet engine only as a turbogenerator would seem to involve excessive modifications, time, and expense for the gains expected.

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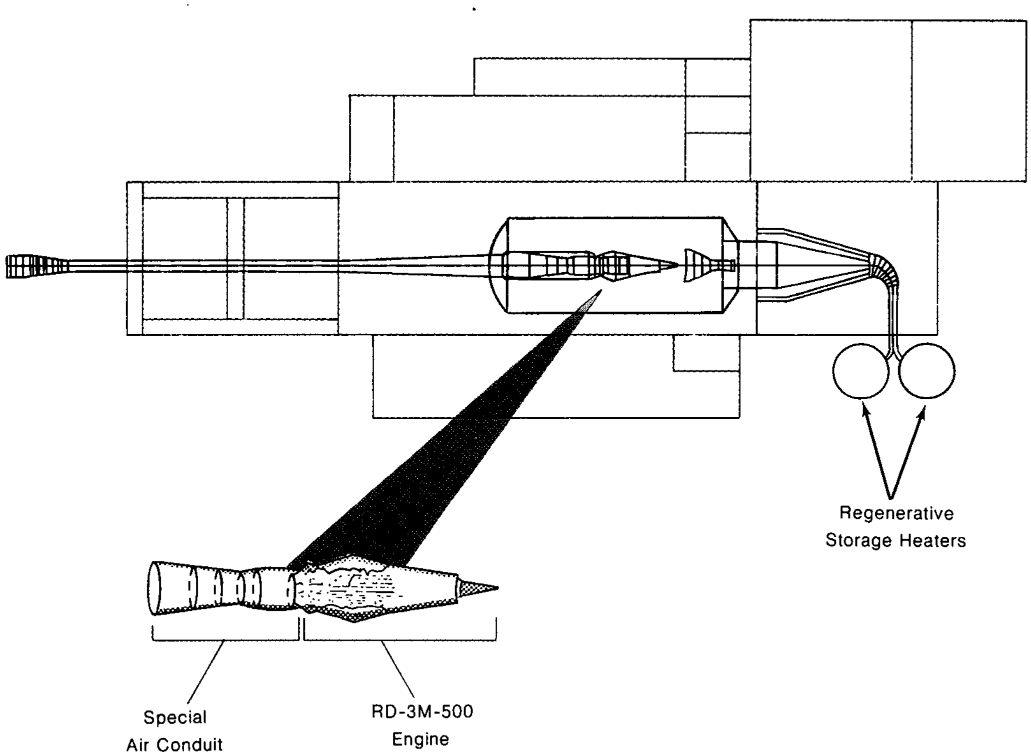
Figure 14

Possible Configuration of HTCB



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The optics/mirror mounts observed at the diagnostics building were probably used to focus the beam being propagated downrange through the six safety panels to the target building. The Soviets probably studied the focused beam's energy distribution and effects in the atmosphere. The limited flexibility of the range and the hole diameters in the panels indicate that the range is primarily intended for the development, initial testing, and checkout of the laser device. Tests that could be done at this range include studying the gas flow characteristics of a laser, studying the interaction between a laser and its optical systems, and testing a laser to be sure it is operating according to specifications. [redacted] 25X1

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We do not have any information to indicate the success of the laser research, development, and test program at Kazan. [redacted] 25X1 25X1 it may have been part of the R&D effort for the probable high-energy laser system that was installed in the early 1980s on a modified IL-76 (Candid) transport aircraft at Taganrog airfield. Since September 1982, this aircraft has been observed at Shchelkovo airfield near Moscow where there are newly built facilities suitable for conducting ground tests of an airborne HEL.[1] [redacted] 25X1 25X1

Estimated Time of Testing at the Range

Based on the timing of construction modifications and dismantlement, we can estimate the period of time when laser testing could have occurred at Kazan. New construction and modifications to the existing structures at the laser range began in May 1975 and were completed in April 1978. Dismantlement of the safety panels began in May 1980. Therefore, testing could have taken place between April 1978 and May 1980. [redacted] 25X1

[redacted] 25X1

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